Technology

What is a computer?

The term 'computer' originally referred to *people* whose job it was to perform repeated numerical calculations according to a set of instructions (i.e. an algorithm). Since the 1940s it has been used to refer to digital machines that accept data input, process this according to some set of stored instructions (i.e. a program) and output some sort of information.

The power of digital computers comes from their ability to run through these stored instructions incredibly quickly. The silicon chip at the heart of a modern smartphone can execute over a billion instructions per second!

A digital computer comprises two inter-related systems.

- Hardware: the physical components, including the processor, memory, power supply, screen, etc.
- Software: the core **operating system**, embedded control programs, compilers or interpreters and many application programs.

There is an incredible variety of electronic devices that contain some sort of digital computer. There are two different types of device:

Computer-controlled for specific purpose

- digital watch
- digital television
- digital camera ...

Programmable computer – can do many different things

- laptop
- tablet
- smartphone ...

How do computers remember things?

The memory of a computer stores both the programs it needs to operate and the **data** that it processes. There are different types of computer memory and usually there's a trade-off between speed and cost. These days, high capacity storage has become very cheap, so that data centres can provide users with vast amounts of storage for little or no cost through services such as Microsoft OneDrive and Google Drive.

Irrespective of where programs or data are stored in computer memory, they are always stored in a digital format. Information is represented as sequences of numbers. The numbers themselves are stored in a binary code, represented using just two symbols: 0 and 1 (this number system is called base 2). Each 0 or 1 is called a bit.

A range of standard codes are used to convert machine code, images, sound or video into a digital format. These provide standard ways to represent information of different types in binary. Text data is encoded in Unicode. A byte is a group of eight bits; it's used as a unit of memory. Eight bits are more than enough to store one character from the Latin alphabet, in upper or lower case, a punctuation symbol, a digit, etc. One thousand bytes make a kilobyte: enough to store 1000 characters (a short paragraph).

Images, sound and video have their own accepted standards for being encoded digitally, such as bitmaps for images or 'WAV' files for audio. These typically take up much more room than text, so often a form of compression is used (where patterns in the data help reduce the amount of storage space needed). If the original data can be recovered perfectly this is

called lossless compression. If some of the original information is thrown away, the original image, sound or video can be stored in a much more compact format, although some of the original quality is lost in the process: this is 'lossy' compression.

Interestingly, the key stage 2 programme of study is more concerned with how information is communicated than how it's stored, but binary representation should be covered in:

- 'work with … various forms of input and output'
- 'understand **computer networks**, including the internet'.[1]

How do computers interact with the real world?

In order for a computer to be able to do anything in the real world, it needs some form of input (to receive data) and some form of output (to push information back out).

The form of input will vary:

Laptop inputs
- keyboard
- trackpad/touchpad
- microphone
- webcam
- through a port (e.g. USB mouse)
- via a network connection …

Smartphone inputs
- touch-sensitive screen
- buttons
- microphone
- camera
- GPS receiver
- accelerometer
- barometer
- through a port
- via a network connection …

A computer will need to convert the analogue, real-world data it receives into a digital format before it can be processed, stored or transmitted. We call this process digitisation and it inevitably involves throwing away some of the fine detail of the real-world information.

[1] National Curriculum in England, *Computing Programmes of Study* (Department for Education, 2013).

Computers can produce many different forms of output:

Laptop/desktop PC outputs
- screen
- speakers
- printer
- headphones
- network connections …

Smartphone/tablet outputs
- screen
- speakers
- small motor to produce vibrations
- bright LEDs used as a flash
- network connections …

What is a robot?

A robot is a computer that can move. This could be a single, integrated system such as a **programmable toy**, or it could be a motor under a computer's control, such as a robotic arm in manufacturing.

Robots are used widely in industry, where repetitive tasks can be performed effectively and efficiently by machines. As 'smarter' algorithms have been developed by computer scientists, more and more decision-making capabilities can be built in to the robot, so that it can autonomously react to changes in its environment.

Further resources

- 'Arduino the cat, Breadboard the mouse and Cutter the Elephant': video of a group of girls planning and programming soft toys, available at: http://vimeo.com/4313755.
- Barefoot on 'Computer systems', available at: http://barefootcas.org.uk/barefoot-primary-computing-resources/concepts/computer-systems/ (free, but registration required).
- Barefoot on 'Inputs', available at: http://barefootcas.org.uk/programme-of-study/work-various-forms-input/inputs/ (free, but registration required).
- Barefoot on 'Outputs', available at: http://barefootcas.org.uk/programme-of-study/work-various-forms-output/outputs/ (free, but registration required).
- BBC Cracking the Code: Miniature computers, available at: www.bbc.co.uk/programmes/p01661f7.
- BBC Cracking the Code: Robots, available at: www.bbc.co.uk/programmes/p01661tn.